IN THE CLAIMS

CLAIMS

What is claimed is:

1. (currently amended) A method for correcting signals received from an earth formation using a Nuclear Magnetic Resonance (NMR) tool ~~into~~ in a borehole in said earth formation, the method comprising:

(a) exciting said earth formation with a first pulse sequence having a first recovery time;

(b) exciting said earth formation with a plurality of additional pulse sequences having a second recovery time less than said first recovery time;

(c) determining from spin echo signals resulting from said additional pulse sequences an estimate of a non-formation signal; and

(d) correcting spin echo signals resulting from said first pulse sequence using said estimate ~~and obtaining corrected spin echo signals~~.

2. (original) The method of claim 1 wherein at least one of said additional pulse sequences has a duration less than a duration of said first pulse sequence.

3. (original) The method of claim 1 wherein said second recovery time corresponds to partial recovery of nuclear spins in said earth formation.

4. (original) The method of claim 1 wherein said additional pulse sequences comprise clay bound water (CBW) sequences.

5. (original) The method of claim 1 wherein said additional pulse sequences have durations less than 40 ms.

6. (original) The method of claim 1 wherein said first pulse sequence and said additional pulse sequences comprise CPMG sequences.

7. (original) The method of claim 1 wherein said first pulse sequence and said additional pulse sequences comprise modified CPMG sequence having a tip angle of a refocusing pulse that is less than 180°.

8. (original) The method of claim 1 wherein said additional pulse sequences comprise pulse sequences having a plurality of pairs of phase alternated pairs (PAP) of pulse sequences.

9. (original) The method of claim 6 wherein said plurality of pairs of PAP sequences have a specified phase relationship to each other.

10. (original) The method of claim 8 wherein the number of said pairs of PAP sequences nf, frequency shift between said pairs of PAP sequences δf are related according to:

$$nf \cdot \delta f = \frac{m}{t}$$

where m is any integer that is not a multiple of nf.

11. (original) The method of claim 8 wherein said non-formation signal comprises a ringing from a refocusing pulse.

12. (original) The method of claim 8 wherein said non-formation signal comprises a ringing from an excitation pulse.

13. (original) The method of claim 11 wherein estimating said ringing from said refocusing pulse further comprises:

(i) separately estimating a ringing from each one of said plurality of phase alternated pairs;

(ii) forming a vector sum of said separate estimates.

14. (original) The method of claim 12 wherein estimating said ringing from said excitation pulse further comprises:

(i) separately estimating an echo signal from each one of said plurality of phase alternated pairs; and

(ii) forming a vector sum of said separate estimates of said echo signal.

15. (currently amended) The method of claim 1 further comprising processing said corrected spin echo signals for determining at least one of (i) a T_2 distribution, (ii) total porosity, (iii) bound volume irreducible, (iv) a T_1 distribution, (v) clay bound water, ~~and,~~ (vi) bound water moveable, and (vii) a sum of echos.

16. (original) The method of claim 1 further comprising conveying said NMR tool into said earth formation on one of (i) a wireline, (ii) a drilling tubular, and, (iii) a slickline.

17. (original) The method of claim 1 further comprising:

(i) exciting said earth formation with a second pulse sequence having a recovery time substantially equal to said first recovery time, said second pulse sequence forming a phase alternated pair with said first pulse sequence; and

(ii) determining from spin echo signals resulting from said first and second pulse sequences an additional estimate of said non-formation signal.

18. (original) The method of claim 17 further comprising:

(A) comparing said estimate and said additional estimate of said non-formation signal; and

(B) using a result of said comparison as an indication of a change in said earth formation between positions of said NMR tool at excitation with said first and second pulse sequences.

19. (currently amended) An apparatus for conducting logging operations in a borehole in an earth formation, the apparatus comprising:

(a) a magnet on a Nuclear Magnetic Resonance (NMR) tool ~~for polarizing~~ which polarizes nuclear spins in a region of interest in the earth formation;

(b) an antenna on the NMR tool ~~for~~ which:

(A) ~~exciting~~ excites said earth formation with a first pulse sequence having a first recovery time;

(B) ~~exciting~~ excites said earth formation with a plurality of additional pulse sequences having a recovery time less than said first recovery time;

(c) a processor ~~for~~ which:

(C) ~~determining~~ determines from spin echo signals resulting from said additional pulse sequences an estimate of a non-formation signal, and

(D) ~~correcting~~ corrects spin echo signals resulting from said first pulse sequence using said estimate ~~and obtaining corrected spin echo signals~~.

20. (original) The apparatus of claim 19 wherein said additional pulse sequences comprise clay bound water (CBW) sequences.

21. (original) The apparatus of claim 19 wherein said additional pulse sequences have durations less than 40 ms.

22. (original) The apparatus of claim 19 wherein said first pulse sequence and said additional pulse sequences comprise CPMG sequences.

23. (original) The apparatus of claim 19 wherein said first pulse sequence and said additional pulse sequences comprise modified CPMG sequence having a tip angle of a refocusing pulse that is less than 180°.

24. (original) The apparatus of claim 19 wherein said additional pulse sequences comprise pulse sequences having a plurality of pairs of phase alternated pairs (PAP) of pulse sequences.

25 (original) The apparatus of claim 24 wherein said plurality of pairs of PAP sequences have a specified phase relationship to each other.

26 (original) The apparatus of claim 24 wherein the number of said pairs of PAP sequences *nf*, frequency shift between said pairs of PAP sequences δf are related according to:

$$nf \cdot \delta f = \frac{m}{t}$$

where m is any integer that is not a multiple of nf.

27 (original) The apparatus of claim 24 wherein said non-formation signal comprises a ringing caused by a refocusing pulse.

28 (original) The apparatus of claim 24 wherein said non-formation signal comprises a ringing caused by an excitation pulse.

29 (currently amended) The apparatus of claim 24 wherein said processor estimates ~~said~~ ringing caused by ~~said~~ an refocusing pulse by:

(i) separately estimating a ringing from each one of said plurality of phase alternated pairs;

(ii) forming a vector sum of said separate estimates.

30 (currently amended) The apparatus of claim 25 wherein said processor estimates ~~said~~ ringing caused by ~~said~~ an excitation pulse by:

(i) separately estimating an echo signal from each one of said plurality of phase alternated pairs; and

(ii) forming a vector sum of said separate estimates of said echo signal.

31 (currently amended) The apparatus of claim 21wherein said processor further determines from said corrected spin echo signals at least one of (i) a T_2 distribution, (ii) total porosity, (iii) bound volume irreducible, (iv) bound water movable, (v) clay bound water, ~~and,~~ (vi) a T_1 distribution, and (vii) a sum of echos.

32. (currently amended) The apparatus of claim 19 further comprising a conveyance device for conveying said NMR tool into said borehole, said conveyance device selected from (i) a wireline, (ii) a drilling tubular, and, (iii) a ~~slickline~~ slickline

33. (currently amended) The apparatus of claim ~~15~~ 19 wherein said transmitter further excites said earth formation with a second pulse sequence having a recovery time substantially equal to said first recovery time, said second pulse sequence forming a phase alternated pair with said first pulse sequence; and wherein said processor further determines from spin echo signals resulting from said first and second pulse sequences an additional estimate of said non-formation signal.

34. (original) The apparatus of claim 33 wherein said processor further:

(i) compares said estimate and said additional estimate of said non-formation signal; and

(ii) provides an indication of a change in said earth formation between positions of said NMR tool at excitation with said first and second pulse sequences.